(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 763 807 B2

(12) NEW EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the opposition decision:
16.08.2006 Bulletin 2006/33

(45) Mention of the grant of the patent:
20.12.2000 Bulletin 2000/51

(21) Application number: **96113768.4**

(22) Date of filing: **28.08.1996**

(51) Int Cl.:
G08G 1/0967 *(2006.01)*

(54) Method of determining road traffic conditions

Verfahren zur Bestimmung von Strassenverkehrszuständen

Procédé pour determiner des conditions de traffic routière

(84) Designated Contracting States:
DE FR GB

(30) Priority: **14.09.1995 US 528292**

(43) Date of publication of application:
19.03.1997 Bulletin 1997/12

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EP 0 763 807 B2

Description

[0001] This invention relates to communications systems and more particularly to a method for estimating and delivering road condition information to communications services users.

Background Of the Invention

[0002] Recent developments in satellite systems technology, such as Low Earth Orbit (LEO) satellites and Very Small Aperture Terminals (VSAT), have provided the impetus for the creation of a wide variety of mobile communications services. These services include personal satellite telephone services and global positioning service (GPS). Prominent among the services provided under the umbrella of global positioning are real-time locator and navigation services for automobile drivers and pedestrians, not to mention security- and military-related applications. The real-time locator service identifies the relative position of a device within a few feet of the real coordinates of the device. By contrast, the navigation service provides directions to an end-user (in the form of digital maps, for example) based on a user's position as well as traffic congestion with respect to that position. Unfortunately, market acceptance of global positioning service has been slower than anticipated by the GPS planners and designers. This is primarily because global positioning service providers have to spread the high cost of procuring and launching (LEO) satellites over a small customer base.

[0003] In an attempt to offer similar services at a lower price, systems designers have developed a surface transportation monitoring system called "Intelligent Vehicle Highway System" (IVHS). That system uses video-based detection devices and road sensors to collect real-time traffic data and to deliver warning and alternate route information to users when traffic congestion occurs. The infrastructure for the Intelligent Vehicle Highway System is probably less costly than the infrastructure of the Global Positioning System, which would lead to an expectation of lower cost for IVHS-based service. Sadly, IVHS developers have found out that because I VHS service is limited to congestion detection/management and traffic reporting, the IVHS customer base may even be smaller than the one for GPS. Hence, the smaller IVHS customer base may operate to vitiate any competitive advantage IVHS may enjoy over GPS. This issue is further complicated by the fact that major radio stations broadcast periodic traffic condition reports targeted at drivers on major metropolitan highways. Thus, it is unlikely that radio listeners on the road would pay for a service that is available to them practically free-of-charge, unless the service includes features heretofore unavailable. The radio stations typically receive the traffic report information that they broadcast from sources such as reporters on board strategically located helicopters. Alas, the radio-broadcast traffic information reporting service is delivered primarily during rush hours, and is targeted primarily to listeners on major highways. The delivery time and scope of the radio-broadcast information operate to make that information worthless to drivers who are traveling either during non-rush hours, or on a congested secondary highway or a suburban road. In addition, the radio-broadcast traffic information reporting service does not offer detailed alternate paths to allow targeted drivers/listeners to avoid the congested area. Furthermore, the radio-broadcast traffic information "ages" rapidly (typically, far more rapidly than the radio-broadcast report frequency) as new accidents occur and old ones no longer hamper road traffic. Another known system is set forth in United States Patent No. 5,182,555 ("Sumner") which discloses a technique to provide real-time traffic congestion data to drivers of suitably equipped vehicles. The Sumner system includes apparatus for gathering and formatting data at a central location, transmitting the data to vehicles, processing data in the vehicles and presenting it to the drivers. The Sumner system design provides inputs for a wide range of data sources at a central location where, through a data fusion process, information from a range of sources may be accumulated and aggregated into a single congestion level data value for each section of road. In the vehicles, a range of options may be available for presenting relevant congestion data to the driver including text, voice and map displays. One data source used for input at the central location in the Sumner system may be electronic tracking devices installed in a number of individual motor vehicles. The electronic tracking devices are special devices installed in individual motor vehicles that transmit tracking data in the form of latitude, longitude, distance, heading, and velocity to the communication system over a radio link, or alternatively, a telephone communications interface. Unfortunately, the Sumner system requires the deployment of a costly information collection infrastructure, which includes electronic tracking devices. Thus, a problem of the prior art is lack of an "anytime, anywhere" solution that allows delivery of road congestion information to users without deploying a new costly information collection infrastructure.

A cellular telephone location system with a wireless communications network of the general kind considered herein is known from WO 94/27160.

EP 0 631 453 A2 discloses a method of locating mobile stations in a digital telephone network.

Summary of the Invention

[0004] The above problem is solved by the method of claim 1. Thus, the present invention is directed to a method which estimates traffic conditions in the thoroughfares located in one or more radio coverage areas of a wireless communications network based on an analysis of real-time and past traffic information carried on, and collected by, the wireless communications network. The data collection process is performed as part of the registration

operation and hand-off procedure carried out by the wireless communications network. Data analyzed may include, for example, actual (current) and expected (past average) number of a) active-busy wireless end-user devices in one or more cells at a particular period of time, and b) active-idle wireless end-user devices registered in a location area of the wireless communications network.

[0005] According to the invention, an inference of traffic congestion may be made when the number of wireless end-user devices active in a cell or location area exceeds a given threshold. For example, the ratio of actual to expected registered number of wireless devices that are active-busy in a cell and/or active- idle in a location area may be indicative of a bottleneck in one or more major roads located in that cell or in that location area. Furthermore, the same ratio in adjacent cells or location areas provides orientation information regarding bottlenecks on that road. For example, when a cell A and its adjacent cell B to the north are experiencing higher than expected communications traffic while adjacent cell C that is located to the south of A is experiencing communications traffic level equal to or lower than an expected level, an inference is made that a bottleneck is present in the northbound section of the highway or the major road located in cell A. The inference of road traffic congestion based on higher than expected traffic level in particular coverage areas of a wireless network is supported by empirical studies which tend to indicate a direct correlation between traffic jams on a road and increased wireless network traffic in a cell where the congested section of that road is located. The expected traffic level for a cell is derived from past historical data collected by a wireless communications network. The expected traffic level also takes into consideration time-dependent factors, such as time-of-day, day-of-week, day-of-year. Other variables factored in the determination of the threshold level include scheduled events, such as parades and road repairs.

[0006] Also according to the invention, an inference of traffic congestion on a road within the coverage area of a cell or location area may be made when a significant number of wireless devices spend higher than an expected amount of time to traverse that cell or location area. The expected amount of time for a wireless device to traverse a cell is based on past historical data which factors therein time-dependent parameters, such as time-of-day, day-of-week and day-of-year.

[0007] According to a further aspect of the invention, a user may subscribe to the on-demand traffic reporting service which allows the user to be alerted of possible congestion on any road of an itinerary provided by the user. The itinerary may list, for example, different cells in which the subscriber is expected to travel within particular time intervals.

[0008] According to another aspect of the invention, a subscriber may receive unsolicited traffic reports of road congestion and alternate routing information whenever the current cell (location area) in which the subscriber is located and/or cells (location areas) adjacent to that current cell (location area) are experiencing higher than expected wireless traffic.

Brief Description of the Drawings

[0009] In the drawings:

FIG. 1 shows in block diagram format a communications switching system arranged in accordance with the invention to estimate traffic conditions in the thoroughfares located in the radio coverage area of the wireless component of the communications switching system;

FIG. 2 illustrates a table that maps particular cells or location areas to sections of a thoroughfare;

FIG. 3 presents in flow diagram format illustrative instructions executed by a processor in the network of FIG. 1 to collect information on wireless end-user devices located within the radio coverage area of the wireless component of the communications switching system; and

FIGs. 4 and 5 present in flow diagram format instructions executed by different components of the network of FIG. 1 to deliver traffic information to a subscriber in accordance with the invention.

Detailed Description

[0010] Shown in the block diagram of FIG. 1 is a communications switching system that includes a wireless network 20 and a land-line network 30. The land-line network 30 is comprised of interconnected local, tandem and toll switches (not shown) that enable a telephone call to be completed to a wired telephone set (such as set 80) or to be forwarded to wireless network 20. The latter includes modular software and hardware components designed to provide radio channels for communications between mobile end-user devices and other devices connected to the communications switching system of FIG. 1. Wireless network 20 may be an analog communications system using, for example, the Advanced Mobile Phone Service (AMPS) analog cellular radio standard. A detailed description of an AMPS-based communications system is provided in **Bell System Technical Journal,** Vol. 58, No. 1, January 1979, pp. 1-14. Alternatively, wireless network 20 may be a digital communications system implementing well-known code division multiple access (CDMA) or time-division multiple access (TDMA) techniques. Additional information on TDMA and CDMA access techniques can be found in **AT&T Technical Journal,** Vol. 72, No. 4, July/August 1993, pp. 19-26.

[0011] The wireless network 20 is comprised of a

number of base stations 1 to 12, each one of which includes a transceiver, an antenna complex (antenna and tower), and a controller that are arranged to wirelessly communicate with mobile end-user devices 90-93 when they are located in the radio coverage area of one of the base stations. That radio coverage area is referred to in the art as a "cell" for cellular networks and "microcells" for Personal Communications Network (PCN). As the points of access and egress for signals transmitted to, and received from, wireless network 20, base stations 1-12 perform certain call setup functions that include initial channel assignment and supervision of the wireless link establishment.

[0012] At the heart of wireless network 20 is wireless switch 50 that monitors and coordinates the operations of the base stations 1-12. It includes a processor 55 (whose functions are described below) and a Mobile Switching Center (MSC) 52 which provides seamless communications paths for calls (that span the wireless network 20 and the land-lines network 30) by "bridging" radio channels (from wireless network 20) with "wire" channels (from land-line communications network 30).

[0013] Of particular importance among the components of wireless switch 50 is processor 55 that executes some of the call processing instructions shown in FIGs. 3, 4, 5 described below. The processor 55 includes a CPU 101 and a storage area 100. CPU 101 coordinates some of the call processing functions performed by base stations 1-12. Storage area 100 contains, in addition to the processing instructions illustrated in FIGs. 3-5 (contained in general storage area 106), registration and cell counters 104 and 105 and registration and cell timer complexes 102 and 103. The counters and timers may be implemented, for example, as a series of EEPROMs which store the individual values of the counters for each cell and the individual values of the timers for each mobile end-user device in an active-busy state. Other functions performed by CPU 101 include the registration procedure and hand-off operations that allow wireless network 20 to identify, validate and track the location of wireless end-user devices 90-93 within specific radio coverage areas as these devices move within the geographical area covered by the wireless network.

[0014] A well-known registration procedure is the Home Location Register and Visitor Location Register (HLR/VLR) method. In the HLR/VLR method, a location area is assigned to a collection of cells, such as base stations 1-12. According to the HLR/VLR method, an active-idle mobile (i. e., a device that is energized but that is not emitting or receiving speech or data signals) needs to register at the time the device is energized or when the device enters a new location area. Hence, when wireless switch 50 needs to complete a call to one of the mobile devices 90-93, it broadcasts a paging signal only to the cells associated with the location area where the mobile device is registered. When one of the mobile end-user devices 90-93 registers, CPU 101 of wireless switch 50 increments an appropriate counter in registration counter 104 by "one" and starts an appropriate timer in the registration timer complex 102. Conversely, when a mobile device is powered off or exits a location area, the processor 55 of wireless switch 50 decrements the registration counter by "one" and sends a signal to the registration complex 102 to cause the timer associated with that device to reset.

[0015] The hand-off operations are performed by CPU 101 in cooperation with base stations 1-12. Each one of the base stations 1-12 is arranged to measure and assess the strength of signals received from an active-busy mobile device. Hence, as a mobile end-user device crosses the boundary of one of the base stations 1-12 to enter another one of these base stations, the diminished strength of the signal received by the exiting cell impels CPU 101 of wireless switch 50 to initiate the hand-off procedure which assigns a radio channel from the new base station for communications with the mobile end-user device. Processor 55 is arranged to increment by "one" a cell counter for a cell whenever one of the mobile end-user devices 90-93 initiates a call from a location within the coverage area of that cell. CPU 101 also increments by "one" the appropriate counter in cell counter 105 when one of the mobile end-user devices 90-93 (in an active-busy state) enters the radio coverage area of that cell. In that case, CPU 101 also records the cell number of the previous cell to identify the direction being traveled by the user of the mobile end-user device. The mobile end-user devices 90-93 may be cellular telephone sets, two-way pagers, multimedia wireless devices or even low-mobility portable communications devices when wireless network 20 is a Personal Communications Network (PCN).

[0016] As mentioned above, processor 55 also includes a registration timer complex 102 and a cell timer complex 103 which are comprised of a series of EEPROMs with clocks that are associated with particular mobile end-user devices in specific situations. For example, CPU 101 starts a timer for one of mobile end-user devices 90-93 when that device registers. Similarly, when one of mobile end-user devices 90-93 initiates a call or enters a new cell, CPU 101 starts a timer for that device. Both types of timers are designed to reset upon receiving a particular type of signal from CPU 101. That signal is emitted by CPU 101 to a) a registration timer when a user powers off an energized mobile end-user device, and b) to a cell timer when an active-busy mobile end-user device leaves a cell or is tumed off. Even though the cell timer complex 103 is shown as part of the wireless switch 50, it is to be understood that it may be implemented as a stand-alone device or may be alternatively included in a processor of each of the base stations 1-12. Cell timer 103 is arranged to forward a signal to CPU 101 when a timer has exceeded a particular threshold. The value associated with that threshold is based on past average period of time for a driver, for example, to traverse that cell under similar conditions, such as same time-of-day, same day-of the-week and same day-of-the-year. This

past average period of time that is hereinafter referred to as "past average analog equivalent amount of time" is forwarded periodically by CPU 101 to cell timer complex 103.

[0017] Connected to wireless switch 50 is a Voice Information System (VIS) 53 that is arranged to a) initiate calls to mobile end-user devices 90-93 when a particular event occurs, b) receive calls and prompt callers for specific information by asking questions based on a set of modules in a transaction script, c) collect information from a caller in the form of speech input or Dual Tone Multi Frequency, and d) forward collected information to processor 55.

[0018] In addition to the registration and cell counters, processor 55 also stores the table of FIG. 2 which correlates particular cells (shown in the leftmost column) to sections of a thoroughfare (depicted in the second leftmost column). Although the table of FIG. 2 shows only one major thoroughfare per cell, it is to be understood that more than one major thoroughfare may be served by one cell. In that latter case, the strength of the signal received by one of the base stations 1-12 may be used to distinguish which mobile end-user devices are traveling on which thoroughfare. Of course, when a cell serves more than one major thoroughfare, each one of those thoroughfares has its own reference points, alternate routing information and adjacent cells entry in the table of FIG. 2.

[0019] The table of FIG. 2 also includes reference points (shown as the middle column of FIG. 2) which identify the general boundaries of a section of a thoroughfare served by a particular cell. The reference points may be well-known streets, or exit numbers of a highway. Illustrated in the rightmost column of FIG. 2 are adjacent cells whose function in the road bottleneck identification and estimation process is described in detail below. Suffice to say for now that those adjacent cells are oriented in the same direction as the cell serving a particular section of the thoroughfare. By way of example, if highway 1 (shown in the top row of FIG. 2) is oriented in the north-south direction, adjacent cells 2 and 1 are cells that are located to the north and south, respectively, of cell 3. The table of FIG. 2 also includes alternate routing information that represents other thoroughfares oriented in the same direction as the section of a thoroughfare served by a particular cell. Optionally, the alternate route information may be implemented, for example, as pointers to stored digital maps associated with the geographical area served by a particular cell.

[0020] FIG. 3 is a flow diagram of illustrative instructions executed by some of the components of the communications switching system of FIG. 1 to collect information on wireless end-user devices located within the radio coverage area of the wireless network of FIG. 1. The information collection process contemplated by the invention is initiated in step 301 when a user turns on one of the mobile end-user devices 90-93. This triggers the registration procedure, in step 302, which causes CPU 101 to increment by "one" the appropriate counter in registration counter 104 for the location area of the device. If the user initiates a call, as determined in step 303, CPU 101 proceeds, in step 306, to increment by "one" a counter in cell counter 105, and to start a timer in the cell timer complex 103 in step 307. If the user does not initiate a call, a determination is then made, in step 304, as to whether the energized device has been powered off. If so, the registration counter is decremented by "one" to end the information collection process.

[0021] After a call has been initiated (as determined in step 303), the appropriate counter in the cell counter incremented (as shown in step 306) and the timer started (as indicated in step 307), the call is monitored by CPU 101 to determine in step 308 whether the device has left the cell. If so, CPU 101, in step 312, sends a signal to cell timer complex 103 to stop the timer for the device, and to decrement by "one" the counter for the cell exited by the device. Thereafter, a determination is made in step 313 as to whether the device has entered a new cell. If so, steps 306 through 308 are repeated. Otherwise, steps 304 and 305 (as needed) are performed. When it is determined, in step 308, that the device has not left the cell, CPU 101 performs a test in step 309 to ascertain whether the amount of time indicated by the timer exceeds a predetermined threshold represented by the past average analog equivalent amount of time for devices in that cell. When the result of that test is negative, step 308 and other subsequent steps are performed as needed. If the result of the test is positive, CPU 101 performs a second test to determine whether the exception counter has already been incremented for the device in question. If so, step 308 and other subsequent steps are performed as needed. Otherwise, an exception counter is incremented by one in step 310, and step 308 is repeated.

[0022] One of the road traffic estimation and delivery processes of the invention is initiated in step 401, when CPU 101 compares the value indicated by the cell counter for a particular cell (called "call count A") to the expected average number of active-busy devices (B) in that cell under equivalent analog conditions; such as time-of-day, day-of-week, day-of-year. CPU 101 determines in step 402 whether the value of the cell counter. A exceeds the expected average B by more than 25%. It should be noted that this percentage value is provided for illustrative and pedagogical purposes only and therefore do not limit the scope of the invention. If the value of the cell counter A exceeds the expected average B by more than 25%, CPU 101 retrieves the cell profile in step 403 and identifies the direction of a potential-traffic jam in step 404. This is done by comparing the value of the cell counter in each of the adjacent cells (indicated by the cell profile) to the respective expected analog equivalent average of each adjacent cell. The adjacent cells in question are located in the same general direction in which traffic flows in the thoroughfare. Hence; if traffic on a road flows in the north-south direction, and the adjacent cell to the north of the cell of interest is experiencing higher than

the analog equivalent average traffic level, while the adjacent cell to the south of the cell of interest is experiencing wireless traffic level lower than or equal to the analog equivalent average wireless traffic level, a conclusion is reached that the potential traffic jam on the section of the road is in the northbound direction.

[0023] If it is determined in step 405 that the value of the cell counter exceeds the expected average by more than an illustrative value of 50%, in step 406 a message that is indicative of presence of bottlenecks in the section of the thoroughfare (associated with the cell profile) is delivered to subscribers in that cell and other affected adjacent cell(s). If, however, it is determined in step 405 that the cell count is less than 50 %, then a warning message that is indicative of the presence of a potential bottleneck in the section of the thoroughfare (associated with the cell profile) is delivered in step 407 to subscribers in that cell and other affected adjacent cell(s). The format in which those messages may be delivered is described below.

[0024] It is worth noting that in some instances the registration counter may be used as well to estimate road traffic conditions. For example, when the location area covers a geographical area that can be associated with a section of a thoroughfare, the number of active-idle mobile devices registered in that location area may be used to estimate road traffic conditions on that section of the thoroughfare. Alternatively, when a wireless network implements a registration scheme that requires mobile devices to register at the cell level, as opposed to location area level, the technique described in conjunction with FIG. 4 could also be used.

[0025] A second road traffic estimation and delivery process of the invention is initiated in step 501 when CPU 101 compares the value of the exception counter C to the cell count A. When the exception counter has a value that is more than 25% of the value of the cell counter, as determined in step 502, CPU 101, in step 503, retrieves the cell profile table of FIG. 2 Thereafter, CPU 101, in step 504, identifies the direction of a potential traffic jam using the techniques described earlier. If the value of the exception counter is over half the value of the exception counter, as determined in step 505, then a message that is indicative of presence of bottlenecks in the section of the thoroughfare (indicated by the cell profile) is delivered to subscribers in that cell and other affected adjacent cell (s). If however, it is determined in step 505 that the cell count is less than 50 %, then in step 507 a warning message that is indicative of the presence of a potential bottleneck in the section of the thoroughfare (associated with the cell profile) is delivered to subscribers in that cell and other affected adjacent cell(s).

[0026] The aforementioned messages may be delivered in audible format via a call initiated by Voice Information System 53 to a subscriber. The message may also include alternate routing information (associated with the cell) to allow the subscriber to avoid the congested section of the thoroughfare. When the mobile end-user device is a wireless data terminal, the message may be delivered in graphical format in the form of a digital map indicating the location of the bottleneck and directions to other less congested roads. When call waiting features are available for the mobile end-user devices 90-93, an appropriate road condition message may be delivered to a subscriber even when the mobile end-user device of the subscriber is in an active-busy state. Similarly, when the mobile end-user device has simultaneous voice data capability, a digital map can be delivered to a monitor connected to the mobile end-user device even when the device is in an active-busy state.

[0027] It should be noted that the values of the exception counter that trigger the road traffic estimation and message delivery process are provided for illustrative and pedagogical purposes and therefore do not limit the scope of the invention when other values are used.

[0028] It is also worth noting that a combination of the techniques described in conjunction of FIGs. 4 and 5 could be used to implement the principles of the invention. For example, a message indicative of presence of bottleneck in a section of a thoroughfare (associated with a cell profile) could be delivered to subscribers in that cell when both conditions of a two-prong test are satisfied. The first condition may require, for example, that a certain number of active-busy devices in a cell exceed the past average analog amount of time spent in that cell while the second condition may dictate that the number of active-busy devices in a cell exceed the expected average (analog equivalent) number of active-busy devices by a certain percentage value.

[0029] According to one aspect of the invention, users may subscribe to the road traffic estimation and delivery service of the invention by pre-registering for the service. Hence, when a bottleneck occurs on a road that is associated in a cell where the mobile end-user device of the subscriber is active, Voice Information System 53 delivers one of the messages described above to the subscriber. Alternatively, the user may provide an itinerary by speech input or DTMF signal to Voice Information Service 53 which delivers appropriate messages (received from CPU 101) to the subscriber whenever congestion occurs in sections of the road associated with that itinerary.

[0030] The foregoing is to be construed as only being illustrative embodiments of this invention. Persons skilled in the art can easily conceive of alternative arrangements providing functionality similar to this embodiment without any deviation from the fundamental principles or the scope of this invention.

Claims

1. A method of determining road traffic conditions in thoroughfares located in radio coverage areas served by a wireless communications network (20) including a plurality of base stations (1-12), each

serving a cell in the radio coverage areas and a wireless switch (50) coupled to the plurality of base stations (1-12), said method comprising the steps of:

receiving from each of a plurality of cells, via said wireless switch (50) coupled to a base station (9, 10) associated with a cell, real-time registration and cell activity data from active mobile end-user devices (90, 91) currently located in each of said plurality of cells served by the wireless communications network (50); and estimating road traffic conditions in at least one thoroughfare located in at least one of said radio coverage areas based on a comparison (401, 501) of said real-time registration and cell activity data to past analogous equivalent information previously collected by said wireless communications network (50) for said at least one of said radio coverage areas.

2. The method of claim 1 wherein information associated with said estimated road traffic conditions is delivered (406, 407, 506, 507) to at least one user of one of said mobile end-user devices (90).

3. The method of claim 2 wherein said information associated with said estimated road traffic conditions is delivered (406, 407, 506, 507) in audible format to said at least one user of one of said mobile end-user devices (90).

4. The method of claim 2 wherein said information associated with said estimated road traffic conditions is delivered (406, 407, 506, 507) in graphical format to said at least one user of one of said mobile end-user devices (90).

5. The method of claim 2 wherein said information associated with said estimated road traffic conditions is delivered (406, 407, 506, 507) to said at least one user of one of said mobile end-user devices when said one of said mobile end-user devices (90) is in an active-busy state.

6. The method of claim 1 wherein said estimating step further includes the steps of:

tallying (302, 305, 306, 307, 311, 312) at least a portion of said real-time registration and cell activity data to determine a total number of mobile end-user devices that are active in at least one of said radio coverage areas within a given time period; and
determining (401) whether said total number of active mobile end-user devices in said at least one of said radio coverage areas exceeds a first threshold indicated by said past analogous equivalent information for said at least one of said radio coverage areas.

7. The method of claim 6 further comprising the step of:

establishing (405) that a bottleneck is present in at least one section of at least one of said thoroughfares located in said radio coverage areas when said total number of active mobile end-user devices in said at least one of said radio coverage areas exceeds said first threshold by a given percentage.

8. The method of claim 1 wherein said cell activity data include amount of time spent by at least one active mobile end-user device in at least one cell.

9. The method of claim 8 further comprising the steps of:

counting (311) a total number of said active mobile end-user devices that individually spend in said at least one cell an amount of time that exceeds a second threshold indicated by said past analogous equivalent information for said at least one cell; and
ascertaining (505) that a bottleneck is present in at least one section of at least one thoroughfare associated with said at least one cell if said total number is higher than a given percentage of a count of all mobile end-user devices active in said at least one cell.

10. The method of claim 7 or 9 further comprising the step of:

identifying (404, 504) a direction of said at least one thoroughfare in which said bottleneck is present, said identification being based on a relative amount of current wireless activity in at least two cells that are adjacent to said at least one of said radio coverage areas.

Patentansprüche

1. Verfahren zur Bestimmung von Straßenverkehrsbedingungen auf Verkehrsstraßen, die in Funkabdeckungsbereichen gelegen sind, die durch ein drahtloses Kommunikationsnetzwerk (20) bedient werden, welches eine Mehrzahl von Basisstationen (1 bis 12) enthält, von denen jede eine Zelle in den Funkabdeckungsbereichen versorgt, und welches weiter einen Funkschalter (50) enthält, der mit der Mehrzahl von Basisstationen (1 bis 12) gekoppelt ist, wobei das Verfahren folgende Schritte aufweist:

Empfang von Echtzeit-Registrierungsdaten und Zellenaktivitätsdaten von aktiven mobilen End-

verbraucherapparaten (90, 91), die sich augenblicklich in jeder der genannten Anzahl von Zellen befinden, die durch das Funk-Kommunikationsnetzwerk (20) versorgt werden, von jeder aus einer Mehrzahl von Zellen über den Funkschalter (50), der mit einer Basisstation (9, 19) gekoppelt ist, welche einer Zelle zugeordnet ist; und

Abschätzen der Straßenverkehrsbedingungen auf mindestens einer der Verkehrsstraßen, die in dem genannten mindestens einen der Funkabdeckungsbereiche gelegen ist, auf der Basis eines Vergleiches (401, 501) der genannten Echtzeit-Registrierungsdaten und Zellenaktivitätsdaten mit vergangenen analogen entsprechenden Informationen, die zuvor durch das Funk-Kommunikationsnetzwerk (20) für den mindestens einen der Funkabdeckbereiche eingesammelt worden sind.

2. Verfahren nach Anspruch 1, bei welchem die Information, die den genannten abgeschätzten Straßenverkehrsbedingungen zugeordnet ist, zu mindestens einem Benutzer eines der genannten mobilen Endverbraucherapparate (90) gesandt wird (406, 407, 506, 507).

3. Verfahren nach Anspruch 2, bei welchem die genannte Information, welche den abgeschätzten Straßenverkehrsbedingungen zugeordnet ist, in akustischer Form zu dem mindestens einen Benutzer eines der mobilen Endverbraucherapparate (90) gesandt wird (406, 407, 506, 507).

4. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, daß** die genannte Information, die den genannten abgeschätzten Straßenverkehrsbedingungen zugeordnet ist, in graphischer Form an den genannten mindestens einen Benutzer eines der mobilen Endverbraucherapparate (90) gesandt wird (406, 407, 506, 507).

5. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, daß** die Information, die den genannten abgeschätzten Straßenverkehrsbedingungen zugeordnet ist, zu dem genannten mindestens einen Benutzer eines der mobilen Endverbraucherapparate gesandt (406, 407, 506, 507) wird, wenn sich der genannte der mobilen Endverbraucherapparate (90) in einem aktiven Zustand bzw. Besetztzustand befindet.

6. Verfahren nach Anspruch 1, bei welchem der Schritt des Abschätzens weiter folgende Schritte umfaßt:

Buchen (302, 305, 306, 307, 311, 312) mindestens eines Teiles der genannten Echtzeit-Registrierungsdaten und Zellenaktivitätsdaten zur Bestimmung einer Gesamtzahl von mobilen Endverbraucherapparaten, die in mindestens einem der Funkabdekkungsbereiche innerhalb einer bestimmten Zeitdauer aktiv sind; und

Bestimmen (411), ob die genannte Gesamtzahl aktiver mobiler Endverbraucherapparate in dem mindestens einen der Funkabdeckungsbereiche einen ersten Schwellwert übersteigt, der durch die vorausgegangene analoge äquivalente Information für den mindestens einen der Funkabdeckungsbereiche angezeigt ist.

7. Verfahren nach Anspruch 6, welches weiter folgenden Schritt aufweist:

Feststellen (405), daß ein Engpaß in mindestens einem Abschnitt mindestens einer der Verkehrsstraßen vorhanden ist, die in den Funkabdeckungsbereichen gelegen sind, wenn die genannte Gesamtzahl aktiver mobiler Endverbraucherapparate in dem mindestens einen der Funkabdeckungsbereiche den ersten Schwellenwert um einen gegebenen Prozentsatz übersteigt.

8. Verfahren nach Anspruch 1, bei welchem die genannten Zellenaktivitätsdaten eine Zeitdauer enthalten, die von mindestens einem aktiven mobilen Endverbraucherapparat in mindestens einer Zelle verbracht wird.

9. Verfahren nach Anspruch 8, welches weiter folgende Schritte aufweist:

Zählen (311) der Gesamtzahl der aktiven mobilen Endverbraucherapparate, welche jeweils individuell in der mindestens einen Zelle eine Zeitdauer verbringen, welche einen zweiten Schwellenwert übersteigt, der durch die genannte letzte analoge äquivalente Information für diese mindestens eine Zelle angezeigt wurde; und

Feststellen (505), daß ein Engpaß in mindestens einem Abschnitt mindestens einer Verkehrsstraße vorhanden ist, die der mindestens einen Zelle zugeordnet ist, wenn die Gesamtzahl größer als ein gegebener Prozentsatz einer Zählung sämtlicher mobilen Endverbraucherapparate ist, die in der genannten mindestens einen Zelle aktiv sind.

10. Verfahren nach Anspruch 7 oder 9, welches weiter folgenden Schritt aufweist:

Identifizieren (404, 504) einer Richtung der genannten mindestens einen Verkehrsstraße, in welcher sich der Engpaß befindet, wobei die Identifizierung auf der Basis einer relativen Grö-

ße von gegenwärtiger Funkaktivität in mindestens zwei Zellen erfolgt, welche an den genannten mindestens einen der Funkabdekkungsbereiche angrenzen.

Revendications

1. Procédé de détermination de conditions de trafic routier dans des voies de communication situées dans des zones de couverture radio desservies par un réseau de télécommunications sans fil (20) comprenant une pluralité de stations de base (1 à 12), chacune desservant une cellule dans les zones de couverture radio et un commutateur sans fil (50) relié à la pluralité de stations de base (1 à 12), ledit procédé comprenant les étapes suivantes :

   la réception, à partir de chaque cellule d'une pluralité de cellules, par l'intermédiaire dudit commutateur sans fil (50) relié à une station de base (9, 10) associée à une cellule, des données en temps réel d'enregistrement et d'activité de cellule en provenance de dispositifs mobiles actifs d'utilisateur final (90, 91) actuellement situés dans chacune de ladite pluralité de cellules desservies par le réseau de télécommunications sans fil (50) ; et
   l'estimation des conditions de trafic routier dans au moins une voie de communication située dans au moins une desdites zones de couverture radio sur la base d'une comparaison (401, 501) desdites données en temps réel d'enregistrement et d'activité de cellule à des informations équivalentes analogues historiques précédemment recueillies par ledit réseau de télécommunications sans fil (50) pour ladite au moins une desdites zones de couverture radio.

2. Procédé selon la revendication 1, dans lequel des informations associées auxdites conditions estimées de trafic routier sont délivrées (406, 407, 506, 507) à au moins un utilisateur de l'un desdits dispositifs mobiles d'utilisateur final (90).

3. Procédé selon la revendication 2, dans lequel lesdites informations associées auxdites conditions estimées de trafic routier sont délivrées (406, 407, 506, 507) dans un format audible audit au moins un utilisateur de l'un desdits dispositifs mobiles d'utilisateur final (90).

4. Procédé selon la revendication 2, dans lequel lesdites informations associées auxdites conditions estimées de trafic routier sont délivrées (406, 407, 506, 507) dans un format graphique audit au moins un utilisateur de l'un desdits dispositifs mobiles d'utilisateur final (90).

5. Procédé selon la revendication 2, dans lequel lesdites informations associées auxdites conditions estimées de trafic routier sont délivrées (406, 407, 506, 507) audit au moins un utilisateur de l'un desdits dispositifs mobiles d'utilisateur final lorsque ledit dispositif desdits dispositifs mobiles d'utilisateur final (90) est dans un état actif-occupé.

6. Procédé selon la revendication 1, dans lequel ladite étape d'estimation comprend de plus les étapes suivantes :

   le pointage (302, 305, 306, 307, 311; 312) d'au moins une partie desdites données en temps réel d'enregistrement et d'activité de cellule pour déterminer un nombre total de dispositifs mobiles d'utilisateur final qui sont actifs dans au moins une desdites zones de couverture radio à l'intérieur d'une période de temps donnée ; et
   la détermination (401) si ledit nombre total de dispositifs mobiles d'utilisateur final dans ladite au moins une desdites zones de couverture radio dépasse un premier seuil indiqué par lesdites informations équivalentes analogues historiques pour ladite au moins une desdites zones de couverture radio.

7. Procédé selon la revendication 6, comprenant de plus l'étape suivante :

   l'établissement (405) qu'un embouteillage est présent dans au moins une section d'au moins une desdites voies de communication situées dans lesdites zones de couverture radio lorsque ledit nombre total de dispositifs mobiles actifs d'utilisateur final dans ladite au moins une desdites zones de couverture radio dépasse ledit premier seuil d'un pourcentage donné.

8. Procédé selon la revendication 1, dans lequel lesdites données d'activité de cellule comprennent la quantité de temps passée par au moins un dispositif mobile actif d'utilisateur final dans au moins une cellule.

9. Procédé selon la revendication 8, comprenant de plus les étapes suivantes :

   le comptage (311) d'un nombre total desdits dispositifs mobiles actifs d'utilisateur final qui passent individuellement dans ladite au moins une cellule une quantité de temps qui dépasse un second seuil indiqué par lesdites informations équivalentes analogues pour ladite au moins une cellule ; et
   la détermination (505) qu'un embouteillage est présent dans au moins une section d'au moins une voie de communication associée à ladite au

moins une cellule si ledit nombre total est supérieur à un pourcentage donné'd'un comptage de tous les dispositifs mobiles actifs d'utilisateur final dans ladite au moins une cellule.

10. Procédé selon la revendication 7 ou 9, comprenant de plus l'étape suivante :

l'identification (404, 504) d'une direction de ladite au moins une voie de communication dans laquelle ledit embouteillage est présent, ladite identification étant basée sur une quantité relative d'activité sans fil courante dans au moins deux cellules qui sont adjacentes à ladite au moins une desdites zones de couverture radio.

FIG. 1

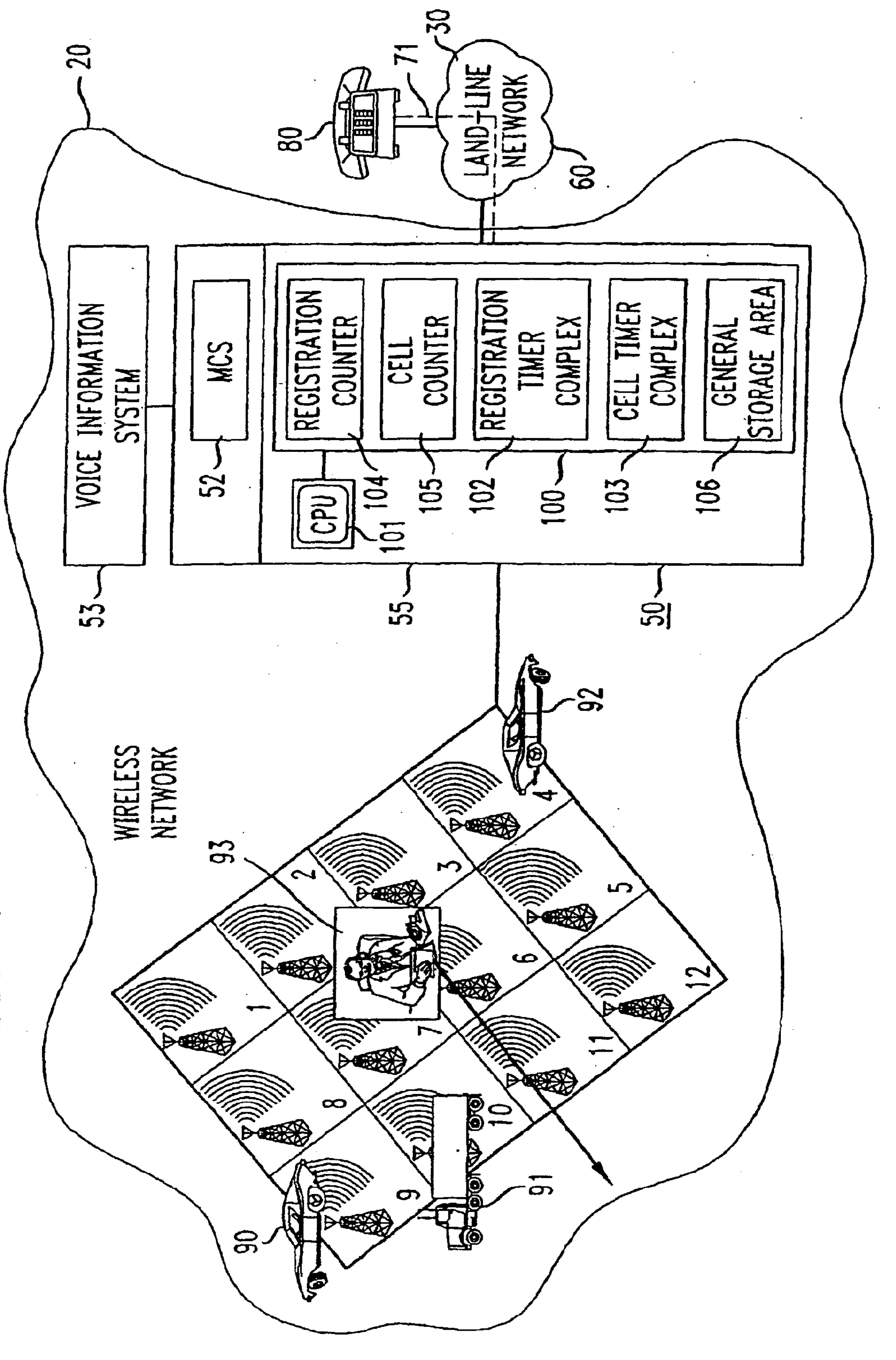

VOICE INFORMATION SYSTEM
MCS
CPU
REGISTRATION COUNTER
CELL COUNTER
REGISTRATION TIMER COMPLEX
CELL TIMER COMPLEX
GENERAL STORAGE AREA
LAND-LINE NETWORK
WIRELESS NETWORK
20
30
50
52
53
55
60
71
80
90
91
92
93
100
101
102
103
104
105
106
1
2
3
4
5
6
7
8
9
10
11
12

FIG. 2

CELLS	THOROUGHFARES	REFERENCE POINTS	ALTERNATE ROUTES	ADJACENT CELLS
CELL 3	HIGHWAY NO.1	TOWN A TOWN B	HIGHWAY 6 ROAD 9	2,1
CELL 7	MAIN ST	SMITH ST JONES ST	HIGHWAY 33	11,12
CELL 25	MEMORIAL PARKWAY	EXIT 5 EXIT 7	EXPRESS FREEWAY	20,23
CELL 38	EASTERN TURNPIKE	EXIT 90 EXIT 93	ROUTE 21	35,33
⋮	⋮	⋮	⋮	⋮
CELL 59	US HIGHWAY NO. 130	BELAIR RD MAPLE AVE	KINGS BLVD	55 58

FIG. 3

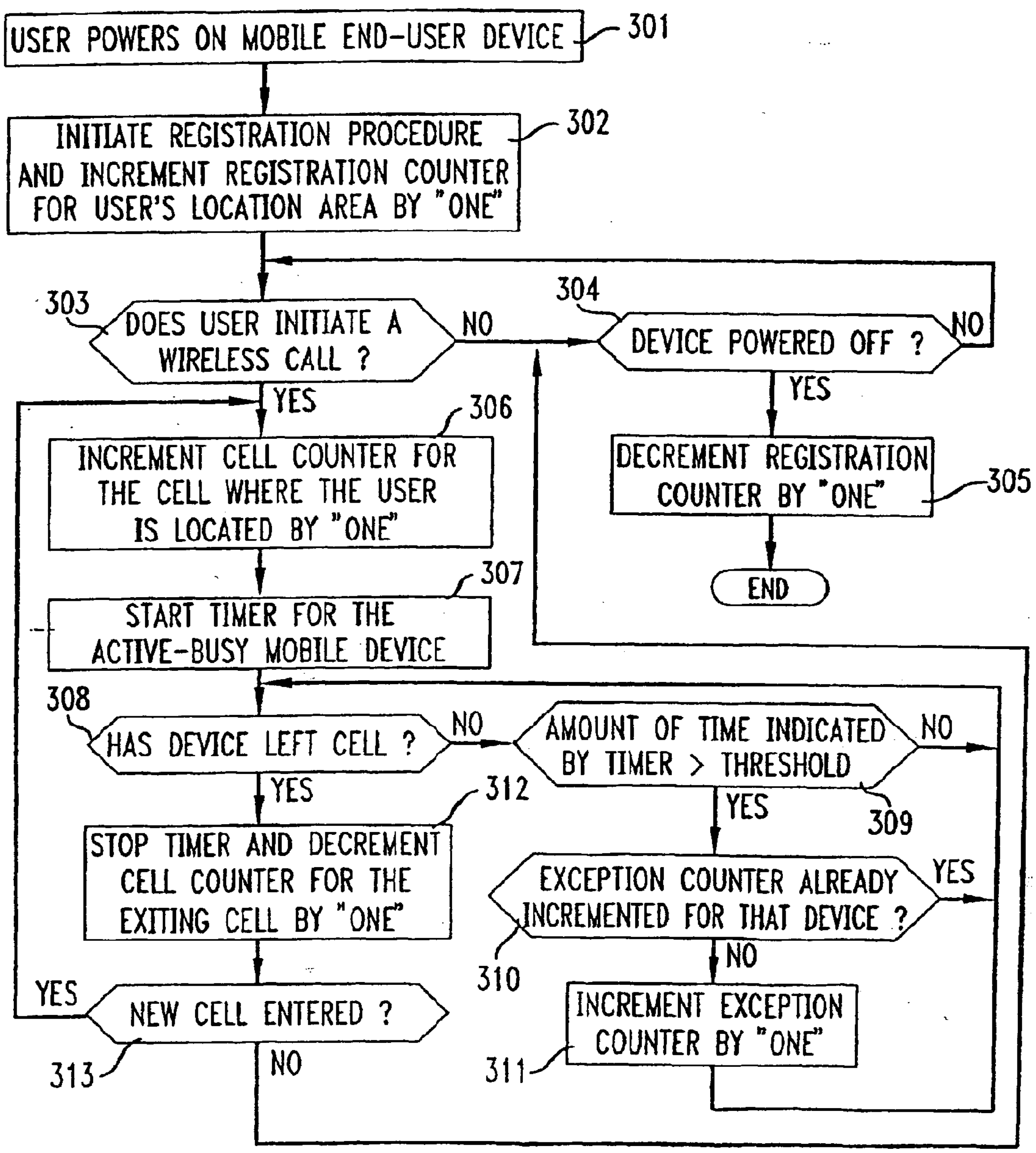

USER POWERS ON MOBILE END-USER DEVICE
301
INITIATE REGISTRATION PROCEDURE AND INCREMENT REGISTRATION COUNTER FOR USER'S LOCATION AREA BY "ONE"
302
303
DOES USER INITIATE A WIRELESS CALL ?
NO
304
DEVICE POWERED OFF ?
NO
YES
DECREMENT REGISTRATION COUNTER BY "ONE"
305
END
YES
306
INCREMENT CELL COUNTER FOR THE CELL WHERE THE USER IS LOCATED BY "ONE"
307
START TIMER FOR THE ACTIVE-BUSY MOBILE DEVICE
308
HAS DEVICE LEFT CELL ?
NO
AMOUNT OF TIME INDICATED BY TIMER > THRESHOLD
NO
YES
309
YES
312
STOP TIMER AND DECREMENT CELL COUNTER FOR THE EXITING CELL BY "ONE"
EXCEPTION COUNTER ALREADY INCREMENTED FOR THAT DEVICE ?
YES
NO
310
YES
NEW CELL ENTERED ?
313
NO
INCREMENT EXCEPTION COUNTER BY "ONE"
311

FIG. 4

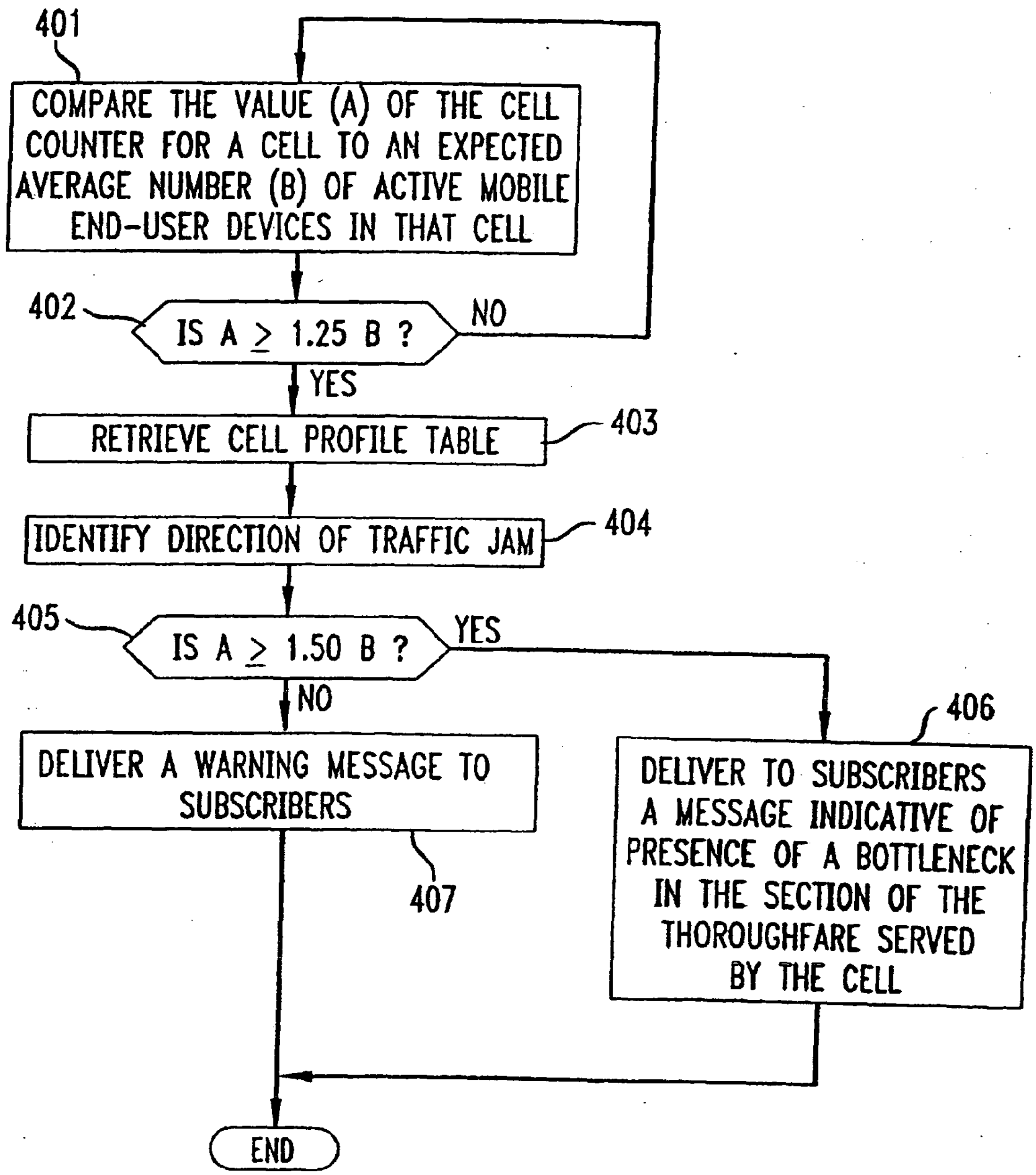
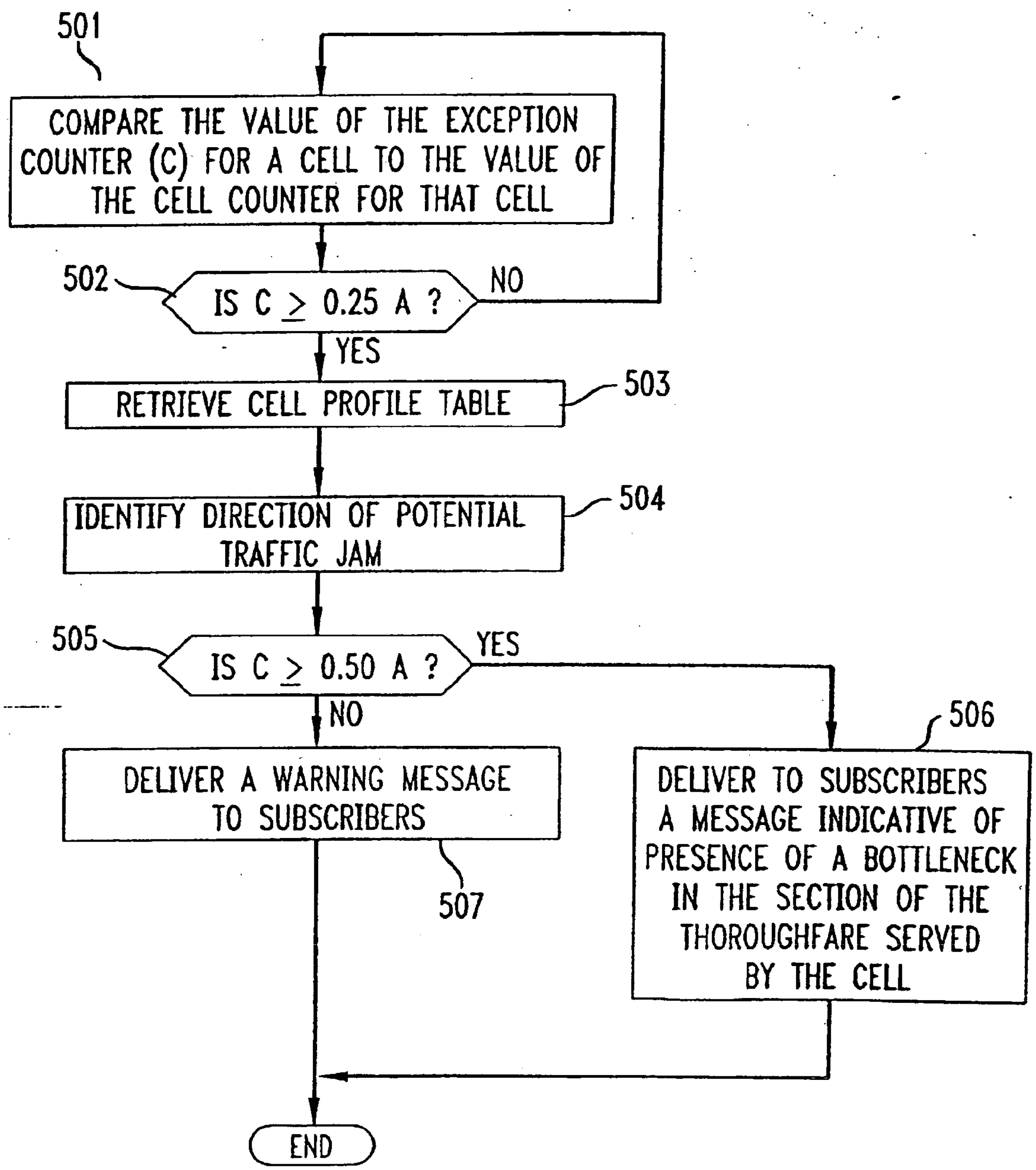

401
COMPARE THE VALUE (A) OF THE CELL COUNTER FOR A CELL TO AN EXPECTED AVERAGE NUMBER (B) OF ACTIVE MOBILE END-USER DEVICES IN THAT CELL
402
IS A ≥ 1.25 B ?
NO
YES
RETRIEVE CELL PROFILE TABLE
403
IDENTIFY DIRECTION OF TRAFFIC JAM
404
405
IS A ≥ 1.50 B ?
YES
NO
DELIVER A WARNING MESSAGE TO SUBSCRIBERS
407
406
DELIVER TO SUBSCRIBERS A MESSAGE INDICATIVE OF PRESENCE OF A BOTTLENECK IN THE SECTION OF THE THOROUGHFARE SERVED BY THE CELL
END

FIG. 5


501
COMPARE THE VALUE OF THE EXCEPTION COUNTER (C) FOR A CELL TO THE VALUE OF THE CELL COUNTER FOR THAT CELL
502
IS C ≥ 0.25 A ?
NO
YES
RETRIEVE CELL PROFILE TABLE
503
IDENTIFY DIRECTION OF POTENTIAL TRAFFIC JAM
504
505
IS C ≥ 0.50 A ?
YES
NO
DELIVER A WARNING MESSAGE TO SUBSCRIBERS
507
506
DELIVER TO SUBSCRIBERS A MESSAGE INDICATIVE OF PRESENCE OF A BOTTLENECK IN THE SECTION OF THE THOROUGHFARE SERVED BY THE CELL
END